EXECUTIVE SUMMARY

This report presents the results of a systematic assessment of environmental, safety and health (ES&H) vulnerabilities at the highly enriched uranium (HEU) facilities of the Department of Energy (DOE). The goal of this assessment is to facilitate the safe management of HEU materials held by the Department. In addition to HEU (i.e., uranium at least 20 percent of which is the fissile isotope uranium 235 [U-235]), the assessment included the fissile and highly radioactive isotope uranium 233 (U-233). It covered more than 250 metric tons of HEU in 175 DOE facilities at 22 sites. All material forms—disassembled weapons parts, reactor fuels, solids, solutions, and scrap and residues—were within the scope of the assessment. Specifically excluded were HEU inventories previously evaluated in the spent nuclear fuel and plutonium ES&H vulnerability assessments, HEU in intact nuclear weapons or outside DOE custody, and waste material containing residual amounts of HEU.

The radiological hazards of HEU, while significant, are not as severe as those of plutonium and spent nuclear fuel which were the subject of earlier vulnerability assessments. The radiological doses from exposure to HEU are thousands of times lower than doses from equal quantities of plutonium or spent nuclear fuel. However, DOE has much more HEU than plutonium. The potential consequences of a nuclear criticality accident involving HEU are generally as severe as a criticality accident involving plutonium. The HEU vulnerabilities should be viewed with these comparisons in mind, while recognizing that HEU presents significant radiological, toxic, and nuclear hazards.

VULNERABILITIES

Vulnerabilities are conditions or weaknesses that could result in the exposure of workers or the public to radiation, or in releases of radioactive materials to the environment. This assessment consisted of physical inspections and analyses of DOE facilities and identified 155 vulnerabilities at 13 sites. Each vulnerability was categorized in terms of facility condition, material/packaging, or institutional weaknesses, and classified in terms of its likelihood and potential impact on workers, the public, or the environment. Most of these vulnerabilities present threats to workers, 16 could adversely affect the public.

FACILITY CONDITION VULNERABILITIES

Most HEU vulnerabilities are the result of deficiencies in facilities where HEU is stored or handled. The Department of Energy's HEU facilities are generally old and suffer from many age-related problems. Eighty-three of the 155 identified vulnerabilities are associated with HEU facility conditions.

Potential facility damage by fires or natural phenomena is the most frequent type of facility condition vulnerability. The fire sprinkler systems in some HEU buildings are inoperable or have deficiencies that would cause them to fail under accident condition. In some facilities, storage of large amounts of combustible materials calls into question the adequacy of the fire protection systems. A large fire is one of the few accident scenarios that has enough energy to drive HEU off-site and thus to impact the public.

Some facilities were found to be especially vulnerable to damage from natural phenomena; specifically, rainwater intrusion, high winds, or earthquakes. At those facilities, high winds or severe earthquakes could potentially lead to the failure of internal or external building structures and the release of HEU. Earthquake damage can also result in the propagation of fires. Water from roof leaks or firefighting activities

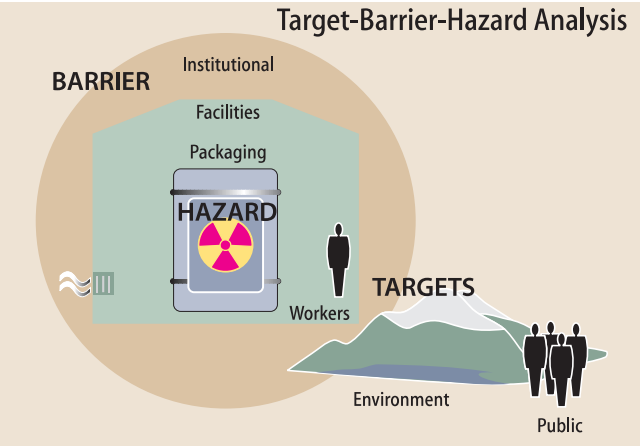
Types of Vulnerabilities

Vulnerabilities can be viewed as potential breaks in barriers that protect the worker, the public, or the environment, and are of the following types:

Facility Condition Vulnerability—deficiency or degradation of facility physical barriers such as the building structure, equipment, or systems important to safety or environmental protection.

Material/Packaging Vulnerability—deficiency or degradation of the package or container for the material due to aging, corrosion, radiolytic damage, or location.

Institutional Vulnerability—breakdown in management systems or administrative controls used to ensure safety or environmental protection (e.g., radiological protection program, facility operational safety requirements, training program).



that is inadvertently mixed with HEU creates a nuclear contamination or criticality hazard. Water slows down neutrons, promoting their ability to cause a nuclear chain reaction with less fissile material than would be needed in a dry state.

Unintentional deposition of HEU in building systems, such as in ventilation ducts, causes contamination problems and in some cases is a criticality concern. Deficiencies of some building ventilation systems have impaired their ability to prevent contamination events. In some facilities, natural gas line, hydrogen generated by collocated plutonium solutions, and compressed-gas cylinders pose the potential for explosion.

MATERIAL/PACKAGING VULNERABILITIES

HEU solutions and solid residues were associated with more vulnerabilities than the metal forms of HEU. Most HEU residues in the DOE complex are stored in packaging that is not suitable for long-term storage. By far, the largest inventory of residues is at the Y–12 Site in Oak Ridge, Tennessee where the curtailment of HEU processing at Building 9212 has resulted in thousands of interim containers being used for extended storage.

Solids containing HEU are stored in carbon steel containers that are now corroding, some severely. Breach of corroded containers could result in the release of HEU and worker contamination. Solutions containing HEU are stored in long, thin polyethylene bottles and in process equipment (e.g, glass extraction columns and tanks) that require monitoring and maintenance to preclude leakage. Leaks and spills from handling of process equipment and storage containers could inadvertently expose workers to HEU. The absence of preventive repackaging programs or preventive maintenance activities has exacerbated the hazard posed by some of these containers.

Twenty-eight material/packaging vulnerabilities were identified in this assessment. About half of these relate to the potential for leaks or spills from the packages or containers, and to poor labeling information. Clear labels provide information for proper handling and storage, and facilitate the identification and tracking of fissile material content, reducing the potential for nuclear criticality accidents. In some cases, the materials in containers cannot be characterized or their condition determined; in others, packaging internal to the containers is expected to have failed. Insufficient characterization of fissile material contents of the packages at some facilities has raised doubts about criticality safety. A criticality event could expose workers to high levels of radiation.

Some containers are especially vulnerable to being inadvertently dropped or knocked over during transportation or maintenance activities. At some facilities, large inventories of containers are at risk of being dislodged by a postulated earthquake.

INSTITUTIONAL VULNERABILITIES

Institutional vulnerabilities are breakdowns in management systems or administrative controls that protect workers, the public, or the environment. Examples of such management systems include the maintenance programs, radiological protection programs, training programs, and safety analysis programs. Institutional vulnerabilities were identified when pervasive deficiencies or programmatic issues made systems or controls vulnerable.

Forty-four institutional vulnerabilities were identified, and nearly one-third of these are in safety analysis programs. Another third of the vulnerabilities in this category relate to maintenance programs, radiological control programs, and training programs. A backlog of maintenance items is evident at several HEU facilities, and at some facilities (e.g., Y–12) is very high. Radiological control program vulnerabilities were also observed at a few sites, and at some sites programs need improvement to ensure worker protection from HEU contamination. At some sites, personnel charged with facility management are uncertain of their HEU inventories, and training programs do not provide requisite knowledge.

The remaining vulnerabilities were found in programs controlling the lock-out and tag-out of important equipment, nuclear criticality safety programs, facility configuration control programs, and radioactive source control programs.

VULNERABILITIES RELATED TO U-233

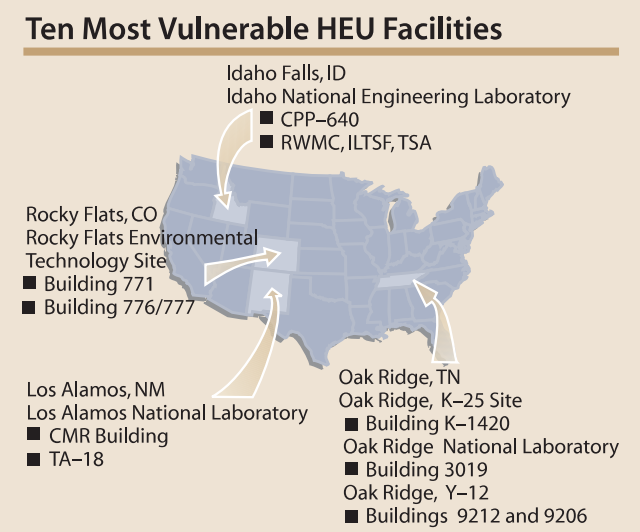
Some of the significant ES&H vulnerabilities involve U-233, which poses significant radiological hazards to the worker. (See Chapter One of this report for sources, uses, and properties of U-233.) This isotope exists in 25 facilities at nine sites in the forms of oxide, fuel elements (irradiated and unirradiated), pellets, and solutions. Small quantities of U-232 coproduced with U-233 during the production cycle cause the external dose to increase over time due to the buildup of a gamma-emitting radioactive decay product. This makes U-233 so radioactive that it must be handled in shielded facilities. Fourteen vulnerabilities involving U-233 were identified. Four of these are among the most significant found in the assessment. U-233 has been stored in metal containers outside on pads, buried in drums in earthen mounds, or stored for decades without inspection. Preliminary studies for disposition options for this material have just begun.

PRIORITIZATION OF VULNERABILITIES

An important feature of this assessment was prioritization of vulnerabilities in terms of their importance to safety. Two approaches were taken: (1) prioritizing the individual vulnerabilities, and (2) identifying those facilities that warrant priority attention.

Facility condition and material/packaging vulnerabilities were classified according to their probability and potential consequences. Those determined to be significant are presented in the Results section of Chapter One. Institutional vulnerabilities could not be classified in that manner because the probability of their causing a release of radioactive material was not possible to quantify.

The overall ranking of vulnerabilities for each site is presented in Chapter Two. In its August 1996 meeting, the Working Group integrated the institutional vulnerabilities with the other vulnerability categories and identified the 10 HEU facilities deemed to be the "most vulnerable." These facilities merit priority attention because of the nature and extent of their vulnerabilities.



CONCLUSIONS

This vulnerability assessment is an integrated effort by DOE Federal staff and its contractors. It incorporates stakeholder involvement and independent peer review. The assessment built on existing information, and most of the vulnerabilities identified here were previously known at their respective sites. Some additional vulnerabilities were identified by independent Working Group teams. Vulnerabilities across the DOE complex were consolidated and prioritized to facilitate the continued safe management of the materials. The following conclusions are drawn:

- All vulnerabilities identified by the assessment warrant evaluation by line management for corrective action. Those identified as most significant merit timely attention.
- Many HEU facilities and packaging configurations are not suitable for extended storage and present hazards to the workers, public, or environment.
- Based on the nature and extent of the vulnerabilities, certain materials and facilities warrant special management action plans to assure safe interim nuclear materials management. They are:
  - The U-233 at the Intermediate Level Transuranic Storage Facility in Idaho.
  - Building 3019 at Oak Ridge National Laboratory.
  - Solutions, residues, compounds, oxides, machine chips, and combustible materials in Buildings 9206 and 9212 at the Y–12 Plant.
- Various forms of materials containing U-233 are stored at a number of different locations. Regardless of which of the U-233 disposition options now being considered are ultimately pursued, a special management plan is needed for safe interim storage of this material.
- A wide variety of package configuration, design, and sizes are used for storage of various forms of HEU at Y–12, Savannah River, and other sites. There are uncertainties about potential failure of these packages. A complex-wide standard is needed for storage of all forms of HEU.

CORRECTIVE ACTIONS

Some of the vulnerabilities identified by this assessment require prompt correction, and others require continuing attention for the safe management of HEU. In conjunction with this report, the DOE's Office of Defense Programs is issuing a management plan for complex-wide corrective actions to address these vulnerabilities. The Department will track that plan, along with those deriving from the earlier spent nuclear fuel and plutonium ES&H vulnerability assessments, to ensure that the deficiencies are corrected.